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APPRENTICESHIP TRAINING

APPLIANCE SERVICEMAN Program

Alberta

ADVANCED EDUCATION AND CAREER DEVELOPMENT
Apprenticeship and Industry Training Division



APPLIANCE SERVICEMAN

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Goal of Apprenticeship Training

The goal of apprenticeship training is to develop a competent journeyman through a combination of on-the-job and technical training.

The graduate of the Appliance Serviceman apprenticeship training is a journeyman who will be able to:

- * responsibly do all work tasks expected of a journeyman.
- * supervise, train and coach apprentices.
- * use and maintain hand and power tools to the standards of competency and safety required in the trade.
- * by skill and knowledge gained through training and experience repair, maintain and operate major and small domestic appliances.
- * use with safety and competence the tools and test equipment required in repair and maintenance procedures.
- * read and understand work orders, prepare estimates, and interpret technical manuals.
- * write service reports, diagnose the cause of failures and keep service analysis records.
- * be thoroughly familiar with the safety requirements pertaining to domestic appliances.
- * utilize the knowledge and may advance to service representatives or supervisory positions.

Course Outline Overview

This course outline has been prepared by the Program Development and Standards Branch of the Apprenticeship and Industry Training Division in partnership with the curriculum subcommittee of the Provincial Apprenticeship Committee for the trade.

This course outline was approved under the authority of the Apprenticeship and Industry Training Board on a recommendation from the Provincial Apprenticeship Committee on October 13, 1992. Valuable input is acknowledged from:

Private Industry
Local Apprenticeship Committees
Technical Training Establishments.

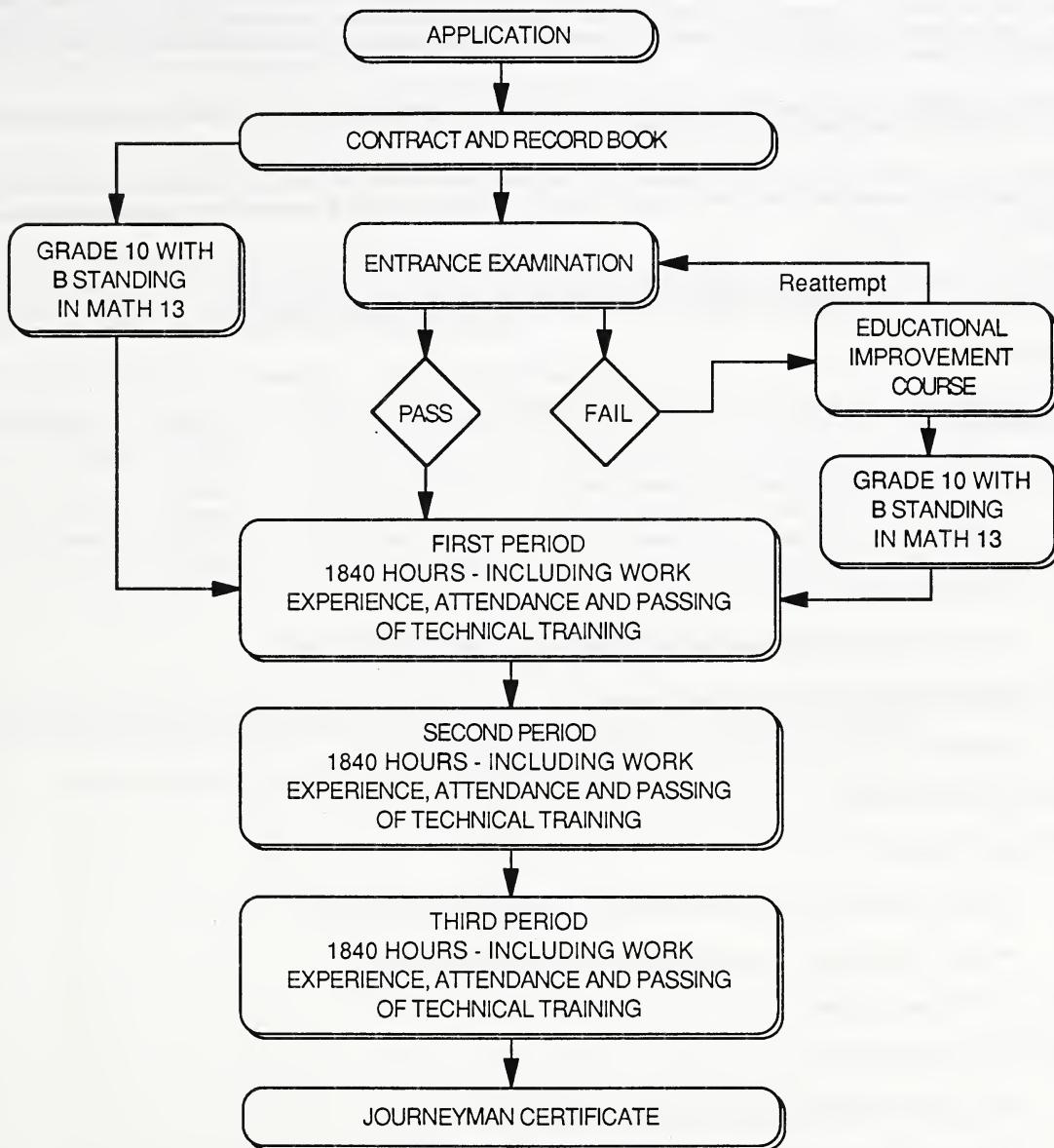
Procedures for Recommending Revisions to the Course Outline

Any concerned citizen or group in the Province of Alberta may make recommendations for change by writing to:

Apprenticeship and Industry Training Division
Program Development and Standards Branch
10th Floor, CityCentre
10155 - 102 Street
Edmonton, Alberta
T5J 4L5.

It is requested that recommendations for change refer to specific areas and state references used. Recommendations received will be placed before regular meetings of the Provincial Apprenticeship Committee.

Apprenticeship Route Toward Certification



Safety Education

Safe working procedures and conditions, accident prevention and the preservation of health are of primary importance in apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of government, employers, employees and the public. Therefore, it is imperative that all parties become aware of circumstances that may lead to injury or harm. Safe learning experiences and environments can be created by controlling the variables and behaviors that may contribute to or cause an accident or injury.

It is generally recognized that a safe attitude contributes to an accident free environment. Everyone will benefit as a result of a healthy safe attitude towards prevention of accidents.

A trades person is possibly exposed to more hazards than any other person in the work force and, therefore, should be familiar with and apply the Occupational Health and Safety Act and Regulations dealing with personal safety and the special safety rules applying to each task.

Legal and Administrative Aspects of Safety

Employer's Responsibilities:

Accident prevention and the provisions of safe working conditions are the responsibilities of an employer. The employer is responsible for:

1. provision and maintenance of safety equipment.
2. provision of protective devices and clothing.
3. enforcement of safe working procedures.
4. safeguards for machinery, equipment and tools.
5. observance of all accident prevention regulations.
6. training of employees in safe use and operation of equipment.

Individual's Responsibilities:

The employee is responsible for:

1. working in accordance with the safety regulations pertaining to job environment.
2. working in such a way as not to endanger themselves or fellow employees.

Government's Responsibilities:

The government is responsible for:

1. ensuring that adequate safety is reflected in the curriculum.
2. ensuring that adequate safety instruction is delivered at the training establishments.
3. periodic inspection of the workplace to ensure that safety regulations for industry are being observed.

Apprenticeship Committee Structure

Provincial Apprenticeship Committees (P.A.C.)

Each trade is guided by a Provincial Apprenticeship Committee which is comprised of employee and employer members who are associated with and knowledgeable in the trade.

This Committee makes recommendations on policies and regulations to the Apprenticeship and Industry Training Board.

The P.A.C also assists in updating of training programs, course outlines, and examinations.

Local Apprenticeship Committees (L.A.C.)

The Local Apprenticeship Committees deal with apprenticeship related matters at the local level. They also make recommendations to their respective Provincial Apprenticeship Committee. Members who serve on these committees are nominated by employer or labour organizations. Membership is comprised of employee and employer representatives in accordance with The Apprenticeship and Industry Training Act.

Appliance Serviceman L.A.C. Members * denotes P.A.C. Members

* Mr. R. Erickson	Calgary	PAC Presiding Officer	* Mr. A. Broyde	Edmonton	Employer
* Mr. R. Hilbrecht.....	Calgary	Employer	* Mr. G. Gemmell.....	Edmonton	Employer
Mr. S. Chung.....	Calgary	Employer (Alternate)	Mr. O. Gildart	Edmonton	Employer (Alternate)
* Mr. J. Conway	Calgary	Employee	* Mr. E. Hyshka.....	Edmonton	Employee
* Mr. J. Huzenga	Calgary	Employee	* Mr. D. Westly	Edmonton	Employee
* Mr. D. Baker.....	Edmonton.....	LAC Presiding Officer	Mr. L. Engel	Edmonton	Employee (Alternate)

Technical Training Establishments

The Appliance Serviceman apprenticeship training program is offered by Alberta Career Development and Employment, Apprenticeship and Industry Training Division. Staff and facilities for delivering the program are supplied by:

1. Southern Alberta Institute of Technology - S.A.I.T. II Campus

Subjects, Topics and Time Distribution

The hours stated are for guidance and should be adhered to as closely as possible. However, adjustments must be made for rate of apprentice learning, statutory holidays, registration and examinations for the training establishment and Apprenticeship and Industry Training Division.

Summary of Topics, Time and Approximate Distribution in Hours

	First Period	Second Period	Third Period	Totals
Electricity	111			111
Electronics	37			37
Conductors, Insulation, Codes and Safety	11			11
Mechanical, Soldering and Brazing	41			41
Gas	22			22
Refrigeration	18	48	93	159
Appliance Components		114		114
Appliance Operating Principles		78		78
Review			12	12
Troubleshooting			75	75
Totals	240	240	180	660

Index of Technical Training Subjects, Approximate Time and Page numbers

FIRST PERIOD	Subject	8 Weeks 30 Hours Per Week	240 Hours	Page
Section One:	Electricity.....		111.....	7
Section Two:	Electronics		37.....	11
Section Three:	Conductors, Insulation, Codes and Safety		11.....	12
Section Four:	Mechanical, Soldering and Brazing		41.....	13
Section Five:	Gas		22.....	15
Section Six:	Basic Refrigeration.....		18.....	16
SECOND PERIOD	Subject	8 Weeks 30 Hours Per Week	240 Hours	Page
Section One:	Appliance Components.....		114.....	19
Section Two:	Appliance Operating Principles.....		78.....	20
Section Three:	Appliance Refrigeration		48.....	21
THIRD PERIOD	Subject	6 Weeks 30 Hours Per Week	180 Hours	Page
Section One:	Review		12.....	24
Section Two:	Troubleshooting		75.....	24
Section Three:	Refrigeration		22.....	25
Section Four:	Domestic Refrigeration and Air Conditioning (Shop)		71.....	27

**FIRST PERIOD TECHNICAL TRAINING
APPLIANCE SERVICEMAN TRADE
COURSE OUTLINE**

Due to the nature of the work of the Appliance Serviceman, it is imperative that safety be taught on a continuous basis throughout this course.

Special emphasis should be placed on weak areas of theory and shop that are evident from progressive tests and examinations administered throughout the course. The time required for such examinations and testing shall be allowed for in each area of instruction.

TOPICS	OBJECTIVES
Upon successful completion of this unit the apprentice should be able to:	
SECTION ONE:	ELECTRICITY
A. Principles of Electricity	38 Hours
1. Fundamentals	1. Explain the fundamental relationship between the structure of the atom and the flow of electrons.
	2. Describe the relationship of voltage, current and resistance in an electric circuit.
2. Ohms law	1. Solve problems using Ohm's Law.
	2. Connect circuits and make voltage, current and resistance measurements to verify Ohm's Law.
	3. Define quantity, express symbols and units of measurement for the following electrical terms: a) volts b) amperes c) ohms d) watts e) watthours f) coulombs
3. Circuits	1. Analyze series, parallel and Edison three wire circuits and identify their applications.
	2. Apply Kirchhoff's current and voltage laws to circuits.
	3. Solve problems involving series, parallel and Edison three wire circuits (balanced and unbalanced).
	4. Describe the effect that an open or high resistance neutral connection will have on electrical equipment (balanced and unbalanced).
	5. Define and distinguish between line loss and voltage drop as it applies to electrical power systems.
4. Energy	1. Define power and energy.

2.	State the units of power and energy.
3.	Calculate electrical power.
4.	Calculate electrical energy and cost.
5.	Magnetism
1.	Describe electromagnetism and its uses.

B. Alternating Current 18 Hours

1. Basic principles
 1. Describe the sine wave.
 2. Explain and calculate average, effective and peak values.
 3. Define:
 - a) vector
 - b) phase
 - c) lead
 - d) lag
 - e) cycle
 - f) angles in electrical degrees
2. Inductance
 1. Define inductance and state its symbol and unit of measurement.
 2. List the factors that affect inductance.
 3. Define inductive reactance and state its symbol.
 4. State the unit of measurement for inductive reactance and its symbol.
 5. State the phase relationship between voltage and current in an inductive circuit.
3. Capacitors
 1. Describe capacitance and the factors which affect it.
 2. Describe the construction and characteristics of an elementary capacitor.
 3. Describe testing for open and shorts.
 4. Describe capacitor types and applications.
 5. State the unit of measurement for the charge of a capacitor and give its symbol.
 6. Give the symbol for capacitive reactance and state its unit of measurement.
 7. State the phase relationship between voltage and current in a capacitive circuit.
4. Impedance
 1. Define impedance and list its symbols.
 2. State the units of measurement for impedance.
 3. Restate formulas required to calculate impedance.

4. State the factors that affect impedance.
5. Use the "impedance triangle" to solve electrical problems.

C. Electrical Measuring Devices 6 Hours

1. Describe the current use, care and safety precautions for:
 - a) ammeters
 - b) voltmeters
 - c) ohmmeters
 - d) wattmeters
 - e) multimeters
2. Demonstrate mode and range selection and connections of a multimeter.
3. Describe what is meant by sensitivity.
4. Demonstrate accurate measurements.
5. Use electrical instruments to confirm electrical failure.

D. Switches and Contacts 6 Hours

1. Recognize and explain the use of the following devices and their symbols:
 - a) momentary contact
 - b) maintained contact
 - c) float switches
 - d) pressure switches
 - e) limit switches
2. Describe the difference in construction and operation between magnetic and thermal relays.
3. Describe the purpose and operation of thermally operated contacts, overloads and thermostats
4. Determine condition of contacts by visual means and resistance test.

E. Transformers 4 Hours

1. Describe the basic components and the purposes of a transformer.
2. Define the primary and secondary windings of a transformer.
3. Differentiate between a step-up and a step-down transformer.
4. State the standard terminal and winding identification.
5. State how transformers are rated and sized.

TOPICS**OBJECTIVES****FIRST PERIOD**

6. Describe and solve problems involving transformer voltage, turns and current ratios.
7. Describe troubleshooting techniques and procedures to confirm transformer failures.

F. Control and Switching Circuits 22 Hours

1. Recognize standard symbols used in schematic and/or wiring diagrams.
2. Demonstrate the ability to develop schematic diagrams and connect equipment to operate as directed.
3. Transpose a schematic diagram to a wiring diagram and transpose a wiring diagram into a schematic diagram.
4. Explain the sequence of electrical operation with the aid of bar charts.
5. Use diagrams to troubleshoot and locate electrical failure.

G. Soldering 3 Hours

1. Demonstrate the basic techniques for soldering and de-soldering electrical components.
2. List the characteristics, of various solders and fluxes, and their uses.
3. Describe the health hazard of using lead based solder.

H. Terminations 2 Hours

1. Describe the importance of electrically and mechanically sound connections.
2. Describe the procedure when splicing dissimilar metals.
3. Describe various types of terminals and their applications.
4. Demonstrate methods of making connections

I. Fuses and Circuit Breakers 2 Hours

1. Define the terms:
 - a) overcurrent
 - b) overload
 - c) short circuit

TOPICS**OBJECTIVES****FIRST PERIOD**

2. Describe and give the purpose of the types of fuses and circuit breakers.
3. Describe how the ambient temperature affects fusing.

J. Single Phase Motors 10 Hours

1. Demonstrate the different characteristics of single phase motors including:
 - a) series (universal)
 - b) split phase (open and sealed)
 - c) capacitor
 - i) capacitor start
 - ii) permanent split capacitor
 - iii) two value capacitor
 - d) shaded pole
 - e) synchronous
2. Demonstrate the installation of solid state, current and potential relays and centrifugal starting switches.
3. Describe motor overload protection.
4. Describe and demonstrate troubleshooting techniques.
5. Describe the relationship between poles and rotational frequency.

SECTION TWO:..... ELECTRONICS 37 HOURS**A. Electronics 37 Hours**

1. Define what is meant by rectification.
2. Identify schematic symbols of the following:
 - a) diode
 - b) transistor (PNP and NPN)
 - c) SCR
 - d) Triac
 - e) zener diode
 - f) varistor
 - g) thermistor
3. Describe the purpose, application and test procedure of:
 - a) SCR's
 - b) Triac's
 - c) diodes
 - d) transistors
 - e) varistor's
 - f) thermistor's
 - g) zener diodes
4. Test electronic boards and devices as per manufacturer's instructions.

5. Describe some problems of static electricity when handling electronic circuit boards.
6. Identify resistor values using color code chart.

SECTION THREE: CONDUCTORS, INSULATION, CODES AND SAFETY 11 HOURS

A. Conductors and Insulators 7 Hours

1. Describe the characteristics and application of the following conductor materials:
 - a) silver
 - b) copper
 - c) gold
 - d) aluminum
 - e) nichrome
2. Interpret a A.W.G. table.
3. List four wire sizes used to supply appliances and quote the fuse rating of each.
4. Describe the relationship between resistance, length, cross sectional area and type of material of a conductor.
5. Define the following conductor terminology:
 - a) hot
 - b) grounded
 - c) neutral
 - d) identified
 - e) ground
6. Specify which circuit conductors must have white or green insulation.
7. Describe the characteristics and application of the following insulation materials:
 - a) neoprene
 - b) plastics
8. Define the term dielectric strength.

B. Electrical Code and Safety 4 Hours

1. Describe the object and scope of the rules of the Canadian electrical code as it applies to:
 - a) grounding of equipment
 - b) soldering fluxes
 - c) C.S.A. approval of equipment and consequences of altering
 - d) limits of the Appliance Serviceman.

2. Identify electrical hazards, safe working techniques and procedures when working with electrical circuits and rotating equipment.

SECTION FOUR:MECHANICAL, SOLDERING AND BRAZING 41 HOURS

A. Mechanical 17 Hours

1. Tools

1. Identify and demonstrate the safe use, care and maintenance of hand tools related to this trade including:
 - a) allen keys
 - b) clamps
 - c) cutters
 - d) drill bits
 - e) files
 - f) hacksaws
 - g) hammers
 - h) pliers
 - i) punches
 - j) reamers
 - k) taps and dies
 - l) screw extractors
 - m) soldering irons
 - n) torches
 - o) micrometer
 - p) calipers
 - q) crimping tools
 - r) wire skimmers
 - s) scrapers
 - t) screwdrivers
 - u) vises
 - v) wrenches
 - i) adjustable
 - ii) box end
 - iii) open end
 - iv) pipe
 - v) socket
 - vi) torque
 - w) flaring tools
 - x) tube bending and cutting tools
 - y) swaging tools
2. Demonstrate the proper use and the hazards of the:
 - a) bench grinder
 - b) drill press
 - c) hydraulic press
 - d) power tools used in the trade

2. Fastening devices

1. Recognize metric and imperial threads.
2. Recognize various fastening devices, including:
 - a) threaded
 - b) spring clips
 - c) rivets

3. Metals

1. Identify and describe the characteristics and uses of the following metals:
 - a) cast iron
 - b) steel
 - c) stainless steel
 - d) aluminum
 - e) pot metal
 - f) copper
 - g) bronze

4. Bearings, belts and lubricants

1. Demonstrate the installation and maintenance of various types of bearings.
2. Describe and demonstrate the application of various types of seals and gaskets.
3. Recognize the condition of drive belts, pulleys and couplings and demonstrate their replacement.
4. Describe various lubricants and their application.

B. Brazing and Soldering.....24 Hours

1. Silver brazing

1. Demonstrate the proper use, care and maintenance of oxy-acetylene brazing equipment, including the:
 - a) setting up and balancing of a torch
 - b) preventing of backfire and flashbacks
 - c) choosing of a rod and flux
2. Demonstrate:
 - a) butt joint
 - b) braze joint
 - c) hard brazing
 - d) low temperature welding
3. Describe safety precautions in dealing with gases.

2. Soldering and brazing

a) gases

1. Describe the characteristics and safety requirements of acetylene, propane and butane.

b) cylinders and related equipment

1. Identify the equipment used for refrigeration soldering and brazing in terms of:
 - a) cylinder colours
 - b) thread design
 - c) connection types and sizes

c) regulators and hoses

1. Describe the construction and operation of gas regulators.
2. Describe the care and handling of hoses.
3. Describe the methods and precautions of detecting leaks in flammable gas equipment.

b) torches

1. List and identify the parts of:
 - a) prestolite type torches
 - b) turbo type torches
2. Select and properly use a variety of torch sizes.
3. Describe and demonstrate the correct lighting and extinguishing procedures.

e) soldering and brazing

1. Properly prepare metal to be joined, including:
 - a) cleaning
 - b) fluxing
2. Describe, grade and use the following solder and brazing materials:
 - a) 50/50 solder
 - b) 95/5 solder
 - c) resin core solder
 - d) silfos
 - e) hard silver solder
 - f) soft silver solder
3. Demonstrate the proper use of the above solders while:
 - a) cleaning joints
 - b) fluxing joints
 - c) soldering
 - d) brazing
 - e) clean-up
4. Successfully join by soldering, brazing pieces of copper tube in several variations of the following sizes:
 - a) 1/4 inch
 - b) 5/16 inch
 - c) 3/8 inch
 - d) 1/2 inch

SECTION FIVE GAS 22 HOURS

A. Gas 22 Hours

1. Describe the characteristics and uses of natural and propane gases.
2. Describe safety precautions in dealing with gases.
3. Adjust gas and air mixture to pilot and main burner.
4. Test thermocouple for output.
5. Test electronic ignition systems.
6. List the fittings used for connecting gas appliances according to the gas code.

7. Review the gas code installation requirements for domestic ranges, dryers and barbecues.
8. Describe operation of the following gas appliances: range, dryer and barbecue.
9. Troubleshoot gas system.

SECTION SIX: BASIC REFRIGERATION 18 HOURS**A. Fundamental Physical Concepts 8 Hours**

1. History	1. Briefly describe the history of domestic refrigeration and air conditioning.
2. Energy	1. Define energy. 2. Describe the two basic laws of thermodynamics.
3. Heat	1. Define heat in terms of energy. 2. Describe how heat is generated.
4. Heat transfer	1. Describe heat transfer in solids, liquids, vapors and vacuums. 2. Define conduction, convection, radiation and sublimation.
5. Sensible heat	1. Define sensible heat. 2. Determine total sensible heat gain in specific substances.
6. Latent heat	1. Define latent heat. 2. Determine total latent heat gain.
7. Changes of state	1. Describe the changes that occur when a substance changes from a solid to liquid then to a vapour and the reverse process. 2. Define saturation. 3. Define sublimation.
8. Superheating and subcooling	1. Define superheating. 2. Define subcooling.
9. Heat units and measurement	1. Define British Thermal Unit (BTU). 2. Define kilojoule (KJ). 3. Solve total heat calculations using BTU's and KJ's.
10. Temperature	1. Define temperature.

2. Describe temperature scales in both Fahrenheit and Celsius.

3. Determine Celsius from Fahrenheit and visa versa.

4. Describe and effectively use temperature measuring devices.

11. Pressure

1. Define pressure.

2. Describe pressure scales in both pounds per square inch (psi) and kilopascals (kPa).

3. Determine kPa from psi and vice versa.

4. Describe and effectively use pressure measuring devices.

12. Gas laws

1. Define Dalton's, Charles' and Boyle's gas laws.

2. Solve problems using the general gas law.

B. Refrigerants and Oils 6 Hours

1. Refrigerants

1. Define refrigerant.

2. Describe requirements for the disposal and reclaiming of refrigerants.

3. List the desirable qualities of a good refrigerant.

4. List hazards associated with the refrigerant used in domestic refrigerating and air conditioning.

2. Refrigerants 12, 22 and 134a

1. Describe each refrigerant including its chemical name and formula and cylinder colour code.

2. List the properties of each that make them desirable for domestic use.

3. List the hazards of these refrigerants for both the user and the service person.

4. Describe the products of combustion of these refrigerants.

3. Oils

1. Define viscosity, pour point, miscibility, wax content and flash point.

2. Describe how oil is added to or removed from a refrigeration system.

C. Refrigeration Cycle 4 Hours

1. Basic cycle

1. Identify and describe the essential components of the basic system.

2. Describe the conditions of the refrigerant as it flows through the cycle.

2. Other cycles

1. Identify and describe:
 - a) the absorption cycle
 - b) the evaporative process
 - c) the thermal electric process
 - d) other processes

**SECOND PERIOD TECHNICAL TRAINING
APPLIANCE SERVICEMAN TRADE
COURSE OUTLINE**

Due to the nature of the work of the Appliance Serviceman, it is imperative that safety be taught on a continuous basis throughout this course.

Special emphasis should be placed on weak areas of theory and shop that are evident from progressive tests and examinations administered throughout the course. The time required for such examinations and testing shall be allowed for in each area of instruction.

TOPICS	OBJECTIVES
	Upon successful completion of this unit the apprentice should be able to:

SECTION ONE: APPLIANCE COMPONENTS..... 114 HOURS

A. Components..... 114 Hours

1. Clothes dryer (gas and electric)	1. Describe the operation principles and applications of these safety features: a) door interlocks b) hi-limit switches c) motor overloads d) fuses and circuit breakers e) ground connections f) heating element
2. Clothes washer	1. Describe the operation of devices for: a) filling b) measuring c) mixing d) moving e) draining of water f) overflow switches
3. Ranges, dryers and barbecues	1. Describe the characteristics of gas burners, with reference to: a) the properties of natural and propane (LP) gas b) igniters c) burners d) valves e) flame proofers f) pilot flame g) electronic ignition systems h) regulators
4. Clothes and dish washers	1. Describe the characteristics and uses of: a) detergent b) bleach c) anti-static material d) citric acid e) rinse agent f) soap

TOPICS**OBJECTIVES****SECOND PERIOD**

5. Clothes washers, dish washers, ranges and dryers	1. Describe the characteristics symbol and application of: a) sequential switches b) magnetic relay c) thermal relay d) reversing switch e) solid state switches
6. Clothes washers and compactors	1. Describe the characteristics and uses of: a) clutch assemblies b) transmissions c) damping and snubbing systems d) pumps
7. Ranges	1. Describe the characteristics of: a) self-cleaning ovens b) convection ovens c) smooth top element d) smoke eliminator e) rotisserie f) timers g) heat switches h) heating element
8. Microwave oven	1. Determine the condition of the Hi-Voltage components including: a) magnetron tube b) transformer c) capacitor d) diode e) door interlock switches f) fuses and circuit breakers

SECTION TWO:.....APPLIANCE OPERATING PRINCIPLES78 HOURS

A. Operating Principles.....78 Hours

1. Describe in sequential form, the operating principles of the following appliances:
a) clothes dryer (gas and electric)
b) clothes washer
c) dishwasher
d) microwave oven
e) range (gas and electric)
f) waste compactor
g) waste disposer
h) barbecues
2. Interpret manufacturers specifications, manuals and drawings for each appliance.
3. Redraw electric circuit diagrams in different forms. (ie. Ladder Type)
4. Demonstrate the use of bar charts and schematic diagrams as an aid in troubleshooting.

SECTION THREE:..... APPLIANCE REFRIGERATION..... 48 HOURS

A. Compressors..... 6 Hours

1. Categories	1. Describe hermetic compressors.
	2. Describe briefly how open and semi-hermetic compressors differ from hermetic compressors.
2. Types	1. Describe the construction and operation of reciprocating compressors.
	2. Describe the construction and operation of rotary compressors.
	3. Briefly describe the construction and operation of a scroll compressor.
3. Hermetic compressor components	1. Describe the construction of the compressor shell.
	2. Identify and explain the purpose of: a) crankshafts b) pistons c) connecting rods d) valves e) oil cooler loops f) mounting springs
	3. Describe hermetic compressor lubrication methods
	4. Differentiate between a compressor's theoretical displacement and actual displacement.
	5. Describe the cooling methods employed for domestic compressor motors and compressors.

B. Evaporator Metering Devices 10 Hours

1. Capillary tubes	1. List applications of capillary tubes.
	2. Describe construction and operating principles.
	3. Describe how to determine evaporator and system superheat.
	4. Describe correct methods of replacing a capillary tube in the system.
	5. List symptoms of: a) overcharge b) undercharge c) restricted capillary tube
	6. Describe the cleaning methods for a restricted capillary tube.
	7. Size and select capillary tubes for various systems using capillary tube selection charts.

TOPICS**OBJECTIVES****SECOND PERIOD**

C.	Evaporator and Condenser.....	6 Hours
<p>1. List purpose, operation and test procedures.</p>		
D.	Refrigerators and Freezers	6 Hours
<p>1. Refrigerators</p> <p>1. Describe the general refrigerator construction and operation for:</p> <ul style="list-style-type: none">a) manual defrostb) cycle defrostc) frost freed) computer controlled		
<p>2. Freezers</p> <p>1. Describe the general construction and operation of:</p> <ul style="list-style-type: none">a) chest freezersb) upright freezers		
<p>3. Ice makers</p> <p>1. Briefly describe icemakers and their operation.</p>		
E.	System Dehydration	4 Hours
<p>1. Principles of evacuation</p> <p>1. Describe the evacuation process.</p> <p>2. List the types of vacuum pumps.</p> <p>3. Describe three methods of system evacuation.</p>		
<p>2. Principle of drying</p> <p>1. Describe dryer construction.</p> <p>2. List the purposes of dryers.</p> <p>3. List the consequences of improper evacuation and dehydration.</p>		
F.	Refrigeration Tools	4 Hours
<p>1. Correctly select and use refrigeration tools for:</p> <ul style="list-style-type: none">a) bendingb) cuttingc) flaringd) swaging <p>2. Maintain and store refrigeration tools in a safe working condition.</p> <p>3. Correctly assemble several lengths of copper tube by various methods used above including bending, swaging and pinching off, for use in leak detection.</p>		

TOPICS**OBJECTIVES****SECOND PERIOD****G. Leak Detection 6 Hours**

1. Bubble method	1. Describe and demonstrate the use of solutions which bubble to indicate gas leaks.
2. Halide leak detectors	1. Describe and demonstrate the proper use of halide leak detectors to indicate gas leaks. 2. Demonstrate the ability to properly maintain a halide leak detector.
3. Electronic leak detectors	1. Describe and demonstrate the proper use and adjustment of electronic leak detectors to indicate gas leaks.

H. Functional Parts 6 Hours

1. Breaker strips	1. Demonstrate the ability to remove and reinstall breaker strips.
2. Doors and door liners	1. List the procedures for removing and replacing doors. 2. Remove and replace a door liner. 3. Properly adjust doors.
3. Trim parts	1. List the procedures for removing and replacing the metal and plastic trim parts. 2. Describe how to remove and replace delicate plastic parts.
4. Shelving	1. Describe the removal and replacement of several shelf types.
5. Leveling	1. List reasons for proper leveling of fridges and freezers. 2. Properly level a refrigerator and a chest freezer.

**THIRD PERIOD TECHNICAL TRAINING
APPLIANCE SERVICEMAN TRADE
COURSE OUTLINE**

Due to the nature of the work of the Appliance Serviceman, it is imperative that safety be taught on a continuous basis throughout this course.

Special emphasis should be placed on weak areas of theory and shop that are evident from progressive tests and examinations administered throughout the course. The time required for such examinations and testing shall be allowed for in each area of instruction.

TOPICS

OBJECTIVES

Upon successful completion of this unit the apprentice should be able to:

SECTION ONE: REVIEW 12 HOURS

A. Electrical

1. Review of electrical theory from previous periods.

B. Air Conditioning

1. Review of air conditioning theory.

SECTION TWO: TROUBLESHOOTING 75 HOURS

A. Electrical Testing 15 Hours

1. Review the use and adjustment of electrical testing meters including:
 - a) clamp-on ammeters
 - b) volt meters
 - c) ohm meters
 - d) multimeters
 - e) meggers
2. Test and trouble shoot defective compressors.
3. Test, trouble shoot and calibrate defective controls and thermostats.
4. Demonstrate the procedures for testing fan motors installed in refrigerators and air conditioners.
5. Demonstrate the procedures for testing other electrical components and circuits from refrigerators and air conditioners.
6. Select proper replacement electrical parts from catalogs.

B. Electronic Testing.....15 Hours

1. Review the use and adjustment of electrical testing meters including:
 - a) milliammeters
 - b) millivolt meters
2. Demonstrate the procedures for testing electronic components and circuits.
3. Select proper replacement electronic parts from catalogs.

C. Appliance Controls.....45 Hours

1. Demonstrate the use of bar charts and schematic diagrams as an aid in troubleshooting faults.
2. Demonstrate the use of suitable instruments to check for:
 - a) electrical resistance
 - b) voltage
 - c) current
 - d) power
 - e) temperature
 - f) microwave leakage
 - g) gas leaks
3. Demonstrate a technique for systematic troubleshooting of appliances.
4. Demonstrate calibration of controls and meters.

SECTION THREE:.....REFRIGERATION.....22 HOURS**A. Defrosting.....2 Hours**

1. Defrosting systems	1. Describe the purpose of defrosting.
	2. List the methods of defrosting.
2. Defrosting components	1. Describe resistance defrost heaters.
	2. Describe radiant defrost heaters.
	3. Describe drain trough heaters.
	4. List and describe the construction and operation of defrost timers.
	5. Describe defrost termination thermostats.
	6. List and describe the components of a hot gas defrost system.

TOPICS**OBJECTIVES****THIRD PERIOD**

3. Defrost system trouble shooting	1. Read and interpret defrost system electrical circuit diagrams. 2. List the common defrost circuit problems.
B. Food Preservation	2 Hours
1. Food spoilage	1. Describe the actions of: a) bacteria b) enzymes c) yeasts d) moulds 2. List the problems that spoiled foods create.
2. Preserving food	1. Briefly describe each of the following methods of food preservation: a) salting b) smoking c) air drying d) freeze drying e) vacuum packaging f) irradiating 2. Describe in detail each of the following methods of food preservation: a) chilling with ice b) cooling by refrigeration c) freezing by refrigeration
3. Food storage	1. Describe the benefits and short comings of short term cooling. 2. Describe the freezing process. 3. Define quick or fast freezing. 4. List and describe the special storage requirements of dairy products.
C. Domestic Air Conditioning.....	6 Hours
1. Properties of air	1. Define each of the following: a) heat content b) moisture content c) humidity
2. Conditioning the air	1. Describe each of the following processes: a) air heating b) air cooling c) humidifying d) dehumidifying e) air cleaning
3. Air conditioners	1. Describe the methods of sizing and selecting domestic air conditioners.

2. List the procedures for installing air conditioners.
3. List the servicing requirements of air conditioners.

D. Refrigeration and Air Conditioning Controls and Circuits12 Hours

1. Refrigeration controls
 1. Describe cold controls (thermostats).
 2. Describe the operation of snap disc overloads and switches.
 3. Describe the operation of electronic and computerized refrigeration control.
2. Air conditioner controls
 1. Describe thermostats.
3. Troubleshooting controls
 1. Describe the methods of determining problems with:
 - a) thermostats
 - b) cold controls
 - c) overloads
 - d) switches
 - e) timers
 2. Interpret control circuit sequencing diagrams.
4. Circuit diagrams
 1. Produce electrical circuit diagrams for:
 - a) manual defrost refrigerators
 - b) cycle defrost refrigerators
 - c) frost free refrigerators
 - d) computer controlled refrigerators
 - e) freezers, both chest and upright
 - f) air conditioners
 2. Properly diagnose circuit problems depicted in a set of sample wiring diagrams.

SECTION FOUR:.....DOMESTIC REFRIGERATION AND AIR CONDITIONING (SHOP).....71 HOURS**A. Troubleshooting15 Hours**

1. Refrigeration system testing
 1. Describe and demonstrate the proper use of refrigeration gauges, manifolds and hoses.
 2. List and describe the various methods for accessing a sealed refrigeration system.
 3. List the suspected problems for the following abnormal system conditions for which a complaint of improper cooling has been lodged:
 - a) condenser pressure high, evaporator pressure high
 - b) condenser pressure high, evaporator pressure low
 - c) condenser pressure low, evaporator pressure high
 - d) condenser pressure low, evaporator pressure low

	e) condenser pressure normal, evaporator pressure low
	f) condenser pressure normal, evaporator pressure high
	g) condenser pressure low, evaporator pressure normal
	h) condenser pressure high, evaporator pressure normal
	4. Demonstrate the trouble shooting of compressors with problems of a non-electrical nature.
	5. Trouble shoot other system components.
2. Electrical diagrams	1. Read and interpret several pictorial diagrams.
	2. Read and interpret several schematic diagrams.
	3. Redraw one pictorial diagram as a schematic diagram for each of the following refrigerators: a) manual defrost b) off cycle defrost c) frost free

B. System Component Replacement18 Hours

1. Compressors	1. Properly remove and seal a defective compressor.
	2. Properly unpackage and prepare a compressor for installation.
	3. Demonstrate the ability to successfully solder or braze the proper refrigerant lines to the compressor.
	4. Properly connect electrical wires to the compressor as necessary.
	5. Run the compressor to insure proper installation.
2. Metering devices	1. List the problems associated with capillary tubes.
	2. Describe the procedures for correcting capillary tube problems.
	3. Describe the selection and replacement of a capillary tube.
	4. List the problems and servicing procedures for: a) thermostatic expansion valves b) automatic expansion valves
3. Evaporators	1. List the steps required to: a) remove a defective evaporator b) prepare an evaporator for installation c) test the system to insure proper installation
	2. List the steps required to: a) repair a defective evaporator b) prepare an aluminum evaporator for repair c) test the system to insure proper repair

4. Condensers	1. List the steps required to: a) remove a defective condenser b) prepare for a condenser installation c) test the system to insure proper installation 2. List the steps required to: a) repair a defective condenser b) prepare a steel condenser for repair c) test the system to insure proper repair
5. Filter/Driers	1. List the steps required to: a) remove a defective filter/drier b) prepare a new filter/drier installation c) test the system to insure proper installation

C. System Evacuation and Charging..... 9 Hours

1. Vacuum pumps	1. Describe and demonstrate the proper use of vacuum pumps. 2. Demonstrate the ability to properly maintain vacuum pumps.
2. System charging	1. List the safety precautions to follow when adding refrigerants to systems. 2. Describe and demonstrate the ability to properly add the correct type and amount of refrigerant to a system.
3. Metering devices	1. List the applications for capillary tubes and expansion valves. 2. Describe how to determine system superheat and how to set it with a thermostatic expansion valve. 3. Describe the procedures for testing metering devices.
4. Recycling	1. Interpret and assess laws and regulations that affect refrigerant use. 2. Describe refrigerants and their uses. 3. Demonstrate safe and effective refrigerant recovering. 4. Demonstrate safe and effective refrigerant recycling. 5. Demonstrate refrigerant reclaim methods. 6. Demonstrate safe and effective refrigerant management. 7. Describe special refrigerant considerations for refrigeration equipment.

D. Ice Makers 8 Hours

1. Operation	1. List the principles of operation of a variety of freezer mounted ice makers. 2. List the principles of operation of a variety of stand alone ice makers.
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TOPICS**OBJECTIVES****THIRD PERIOD**

2. Installation	1. Describe the general installation procedures for ice makers.
3. Repair and maintenance	1. Describe procedures for trouble shooting and cleaning ice makers.

E. Air Conditioners.....18 Hours

1. Operation	1. List the principles of operation of window air conditioners. 2. List the principles of operation of split system air conditioners as installed in existing furnace systems.
2. Repair and maintenance	1. Describe procedures for trouble shooting and cleaning air conditioners. 2. Disassemble and reassemble a window air conditioner. 3. List the steps required to test a window and split system air conditioner.
3. Air conditioning wiring diagrams	1. Read and interpret several different air conditioning wiring diagrams. 2. Draw a wiring diagram for both a window air conditioner and a split system.
4. Sizing and selecting	1. Size and select air conditioning equipment for a variety of air conditioning applications.
5. Installation	1. Describe the general installation procedures for air conditioners.
6. Field trip	1. View a typical window installation. 2. View a typical split system installation. 3. Write a report on the methods used for each installation, paying particular attention to insulation, wiring techniques, tube hanging, neatness of the installation and customer satisfaction.

F. Filters3 Hours

1. Filtration	1. List the reasons for filtering air. 2. List the problems created by dirty air filters.
2. Mechanical filters	1. Describe the construction, removal and replacement of throw away air filters. 2. Describe the construction, and cleaning of washable air filters.
3. Electronic air filters	1. Describe the safety precautions to be observed when inspecting or cleaning electronic air filters. 2. Describe the construction, removal and replacement of electronic air filters.

Textbooks and Supplies List

Apprentices are advised not to purchase any items listed below until after meeting their instructor in the first class. However, if you already own some items listed below bring them with you. Textbooks and some supplies may be purchased from the training institute offering the program, also additional funds may be required to purchase supplies, handouts, etc.

FIRST PERIOD

A. Textbooks

1. Introduction to Electricity and Electronics - Loper Alrand Clendoning
2. Modern Refrigeration and Air Conditioning by Althouse, Turnquist and Bracciano - by General Publishing (optional)
3. Welding Fundamentals by S.A.I.T.

B. Supplies

1. The standard student supplies

SECOND PERIOD

A. Textbooks

1. Handouts from training institute

B. Supplies

1. The standard student supplies

THIRD PERIOD

A. Textbooks

1. Handouts from training institute

B. Supplies

1. The standard student supplies

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